California INSTRUMENTS

Invertron® AC POWER EQUIPMENT

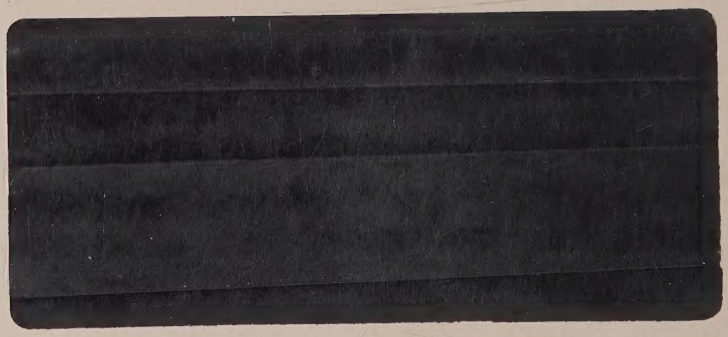
An affiliate of Amstar CORPORATION

California Instruments

A Division of Amstar Technical Products Company, Inc

5150 Convoy Street
San Diego, CA 92111-1266

(619) 279-8620
Telex 695047



California INSTRUMENTS

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INSTRUCTION MANUAL

MODEL 848TCM-3388

AC POWER CONTROLLER

MANUAL ADDENDUM

MODEL 848TCM-2-3388

1.0 GENERAL

The Model 848TCM-2-3388 Programmable Oscillator has been modified from the standard Model 848TCM for use in the Model 350T-2-2-3388 AC Power System. The phase A of the 848TCM-2-3388 provides the drive signal for the Model 251TCA-PC Power Source and phase C for the Model 101T-3388 Power Source.

The Model 848TCM-2-3388 has the following changes from the standard Model 848TCM:

A) Phase B output is disabled.

B) Output frequency is limited to 45-99.99 Hz range.

C) Phase C waveform is shifted 180 degrees with respect to phase A, for system applications.

D) Phase C amplitude is set for a fixed value.

E) Phase C and phase B servo circuits are disabled.

F) øC and øB servo fault detectors are disabled.

2.0 SPECIFICATIONS

All specifications of the standard Model 848TCM apply to the Model 848TCM-2-3388 phase A with the following exceptions:

FREQUENCY RANGE øA & øC:	45 to 99.99 Hz in 0.01 steps.
PHASE:	180 degree seperation between phase A and Phase C.
PHASE C OUTPUT AMPLITUDE:	Not less than 4.5 VAC (fixed value not programmable).

3.0 CALIBRATION

Standard calibration procedure applies to phase A only. Phase B and C are not calibrated.

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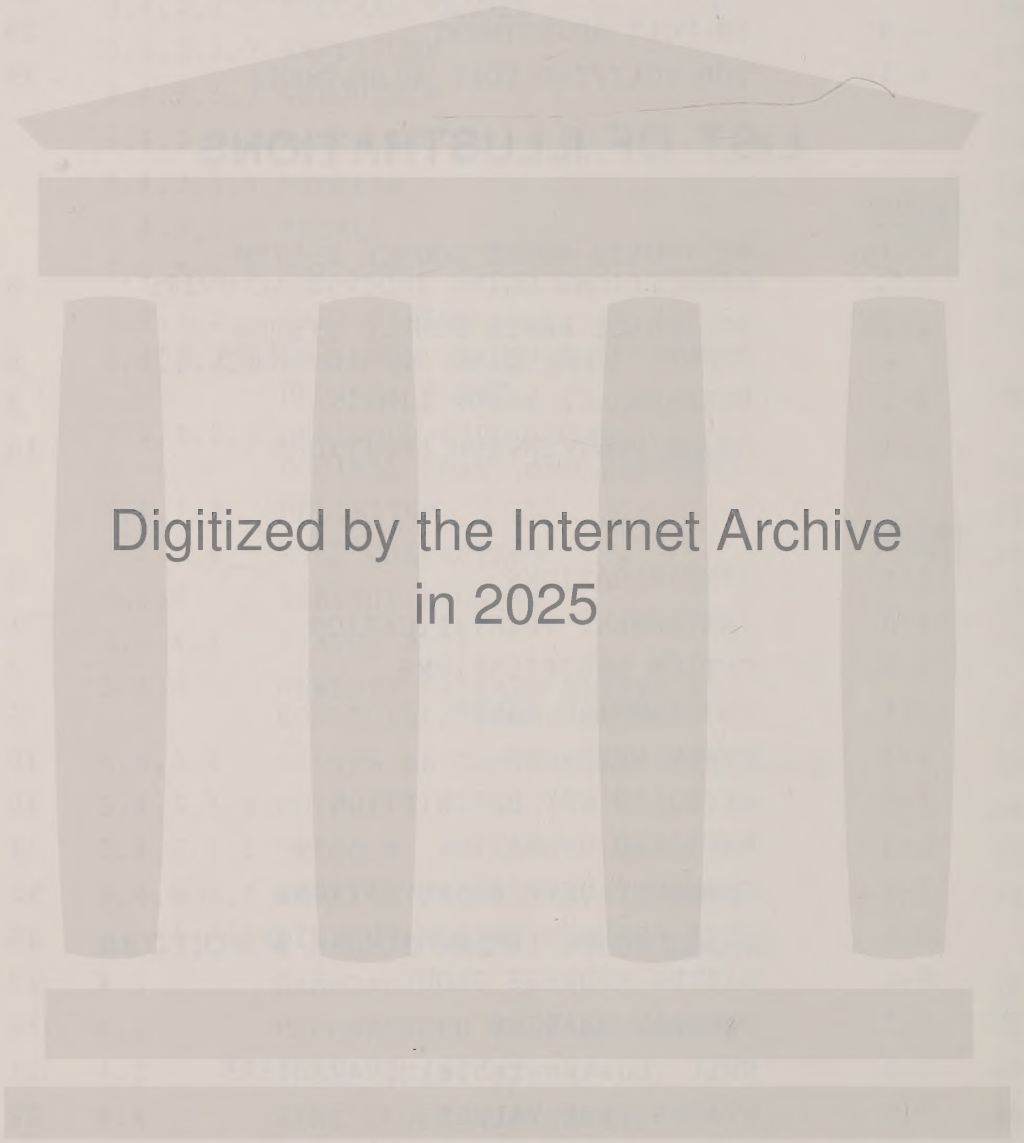

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SPECIFICATIONS

MODEL 848TCM AC POWER CONTROLLER
Table 1-1

AMPLITUDE PROGRAM

VOLTAGE RANGES:	0 to 135 in 0.1 volt steps 0 to 270 in 0.1 volt steps
VOLTAGE ACCURACY: (24 hours, 25°C ±1°C at constant line and load conditions)	±0.1% of full scale from 5% of full scale to full scale. (±0.2% above 5 KHz.)
LOAD REGULATION:	±0.01% of full scale no-load to full load
LINE REGULATION:	±0.01% of full scale for 10% line change
TEMPERATURE COEFFICIENT:	±0.01% of full scale per °C average from 25°C
LONG TERM STABILITY: (25°C ±5°C at constant line and load conditions)	±0.02% of full scale per 1000 hours
DISTORTION:	Less than 1% from 5% of full scale to full scale
DEFAULT (INITIAL) VALUE:	0 volts

FREQUENCY PROGRAM
(25°C ±1°C)

FREQUENCY RANGES:	Standard: 45 to 5000 Hz in 1 Hz steps Optional: 45 to 2000 Hz in 1 Hz steps Optional: 45 to 9999 Hz in 1 Hz steps Optional: 45 to 999.9 Hz in .1 Hz steps Optional: 45 to 99.99 Hz in .01 Hz steps
FREQUENCY ACCURACY: (24 hours)	±0.001% of programmed value
TEMPERATURE COEFFICIENT:	±5 ppm per °C average from 25°C
LONG TERM STABILITY:	±15 ppm of programmed value per year
DEFAULT (INITIAL) VALUE:	Standard: 60 Hz Optional: 50 Hz Optional: 400 Hz

Table 1-1 (cont.)

PHASE:	Two-Phase:	90° separation
	Three-Phase:	120° separation
	Three-Phase Delta:	60° separation

PROGRAMMING

REMOTE: IEEE-488-1978
Subsets; SH1, AH1, T6, L3, SR1, RL2, DC1, DT1

DATA RATE; 200K bytes/second using 256 byte DMA data buffer.

END OF STRING (EOS); END message or standard Line Feed (LF)
Optional Carriage Return, Line Feed (CR)(LF)

PROGRAM FORMAT; IEEE-728-1982

Header Field	HR2	(upper case)
Data Field	NR2 or NR3	
Separator	SR2 or SR3	

Message Headers;

FRQ	Frequency (Hz)
AMP	Amplitude (volts)
PRG	Program
REC	Recall
TRG	Trigger

LOCAL: 16 key Keyboard

DISPLAY

DATA: Four digits with decimal point
ANNUNCIATORS: AMP, FRQ, REM, PRG

ERROR MESSAGES (STATUS BYTE): Data Display (E xx) and Status Byte

FAULT	MESSAGE
Normal	0
Phase A	64
B	65
C	66
A, B	67
A, C	68
B, C	69
A, B, C	70
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" 2 SRQ	82
" 3 SRQ	83
" 4 SRQ	84
" 5 SRQ	85
" 6 SRQ	86
" 7 SRQ	87
" 8 SRQ	88
" 9 SRQ	89

GENERAL

OPERATION TEMPERATURE RANGE:	0°C to +50°C
STORAGE TEMPERATURE RANGE:	-20°C to +85°C
PROGRAM REGISTERS:	Ten (0 through 9)

SECTION 1 GENERAL INFORMATION

1.1 INTRODUCTION

This instruction manual contains information relative to installation, operation and calibration of the Model 848TCM AC Power Controller. The theory of operation with parts lists, schematic diagrams and assembly diagrams are supplied in a separate maintenance manual.

1.2 SPECIFICATIONS

Specifications for the Model 848TCM are listed in Table 1-1.

1.3 INSTRUMENT IDENTIFICATION

The Model 848TCM is identified by specifying its phase, frequency range, initialization frequency and voltage range with a four digit suffix. Table 1-2 explains the Model 848TCM model number structure.

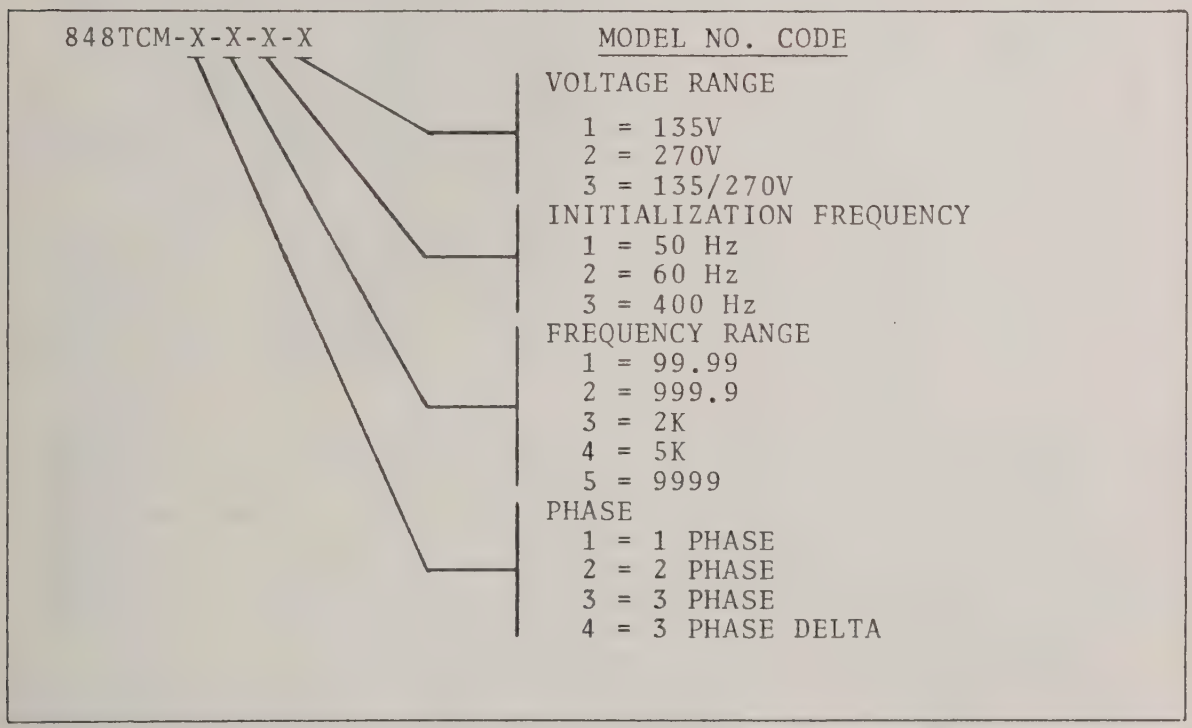


Table 1-2

1.3.1 OPTIONS

The modifications to the Model 848TCM to give the various options described in Table 1-2 are listed in Table 1-3.

PHASE	
-1-X-X-X	M/F 848TCM-1-4-2-1
-2-X-X-X	M/F 848TCM-3-4-2-1; remove A2VR2; cut A2W24
-3-X-X-X	M/F 848TCM-3-4-2-1
-4-X-X-X	M/F 848TCM-3-4-2-1, remove A2VR2; cut A2W19
FREQUENCY RANGE	
-X-1-X-X	Add A1W1; remove A1W3; add A2R35
-X-2-X-X	Add A1W2; remove A1W3; add A2R36
-X-3-X-X	Adjust A1R44 for 2 KHz; verify A1W3 installed
-X-4-X-X	Standard; verify A1W3 installed
-X-5-X-X	Add A1W4; verify A1W3 installed
INITIALIZATION FREQUENCY	
-X-X-1-X	Remove PROM CIC209-01 from A3U17 and install CIC209-02
-X-X-2-X	Standard; verify A3U17 CIC209-01
-X-X-3-X	Remove PROM CIC209-01 from A3U17 and install CIC209-03
VOLTAGE RANGE	
-X-X-X-1	Standard; verify A1S1 is in "ON" position
-X-X-X-2	Switch A1S1 to "OFF" position
-X-X-X-3	Switch A1S1 to "OFF" position; add A1Q9, A1R42, A1R2

Table 1-3

Option Modifications

1.4 DESCRIPTION

The California Instruments' Model 848TCM AC Power Controller is designed as a plug-in controller of frequency and waveform amplitude. The 848TCM will plug into and obtain power from all California Instruments AC Power Sources. The frequency and amplitude are locally controllable by a front panel keyboard or remotely programmable by the IEEE-488 interface. Option PC for the associated power source is required to mount the IEEE-488 interface connector in its rear panel.

The output of the Model 848TCM provides three-phase variable frequency and amplitude drive for the power source. The remote sense input monitors the voltage across the load. The voltage at the sense point will be maintained by the Model 848TCM to be equal to the programmed value. In the event that this voltage cannot be maintained, the Model 848TCM will automatically set the output voltage to zero volts and then step the output voltage in five volt increments to the programmed value. If the programmed voltage is still not maintainable, the Model 848TCM will set the programmed voltage to zero volts and display an error message coincident with the phase or phases generating the fault. The Model 848TCM employs digital techniques for control of the output frequency. A crystal controlled oscillator serves as the clock for the digital frequency generator that controls the output frequency.

This circuit configuration provides the same long-term frequency stability as the crystal time base. The crystal time base is adjusted at the factory for a frequency accuracy of ±5 ppm. The output frequency will, therefore, be equal to ±5 ppm of the programmed frequency.

The Model 848TCM is capable of operating from 45 Hz to 9999 Hz, 999.9 Hz or 99.99 Hz in 1 Hz, .1 Hz or .01 Hz steps depending on the frequency range (see paragraph 1.3). The low end of the frequency range is limited by a frequency detector to 45 Hz. The high end is factory adjusted to the upper full power frequency limit of the associated power source. If an attempt is made to program the frequency outside these frequency limits the amplitude will default to zero volts and the display will show the error message E 71.

The Model 848TCM must be used on the 135 volt range when used with a power source on the 120, 130 or 135 volt range. It must be on the 270 volt range when used with a power source on the 240, 260 or 270 volt range.

.5 ACCESSORY EQUIPMENT

An Extender Assembly, Part No. 4800-703, is available to permit test and adjustment of the Model 848TCM external to the power source.

SECTION 2 INSTALLATION

2.1 GENERAL

This section of the manual details the unpacking and installation requirements for the Model 848TCM AC Power Controller with its associated power source(s).

2.2 UNPACKING

The Model 848TCM is packaged plugged into its associated Phase A power source. The packing container has been specifically designed to prevent damage to the Model 848TCM during shipment. Do not destroy the packing containers until the units have been inspected for shipping damage.

2.3 POWER REQUIREMENTS

The Model 848TCM operates from +25 volts DC and -25 volts DC at 0.1 amperes. In addition, 115 volts AC at 24 VA is required. These supply voltages are normally obtained from an associated power source.

CAUTION

Voltages up to 270 volts AC are present or available in certain associated Invertrons® and 115 volts AC is present on the Phase A Board, A1, of the 848TCM. This equipment utilizes potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with connector pins C and D of the plug-in oscillator, the primary power circuits and output circuits of the associated Invertron® if the oscillator is tested and/or adjusted when connected to Invertron®.

2.4 FUSE REQUIREMENTS

Separate fusing of the Model 848TCM is not required. The 848TCM A1 board has a fuse (F1) that serves as a ground fault interrupter. In the event of a power source malfunction that would normally cause the analog common to be forced above chassis potential, F1 will blow, maintaining digital common at chassis potential.

2.5 POWER SOURCE INTERCONNECTION

The oscillator Phase A, B and C outputs are available respectively on TB1 pins 3, 4 and 5 of a single phase power source.

A three-phase power source has its oscillator phase A, B and C outputs on TB1 pins 3, 5 and 7 respectively. The common is available at TB1 pin 1 for both the single and three-phase power source. The power source signal input is available at TB1 pin 2 for the single-phase power source and at TB1 pins 2, 4 and 6 for the three-phase power source. Refer to Figure 2-1 for the power source connections.

All two-phase 848TCM models (848TCM-2-X-X-X and 848TCM-4-X-X-X) use the phase A and C oscillator outputs.

CAUTION

Failure to connect the sense leads across the load or to the power source output(s) will result in an error message on the 848TCM's Display and output voltage will be zero.

CAUTION

REMOVE POWER FROM THE INVERTRON® BEFORE REMOVING OR INSERTING THE PLUG-IN OSCILLATOR.

The remote sense leads for the phase A, B and C must be connected to the associate power source's TB1 pins 9, 10, 11, and 12 respectively. For single-phase remote sense leads should be TB1 pin 9 to output low, TB1 pin 10 to output high. For two-phase or open DELTA operation, connect remote sense leads as follows:

ϕA Low to TB1 pin 9
ϕA High to TB1 pin 10
ϕC Low to TB1 pin 9
ϕC High to TB1 pin 13

For three-phase operation see Figure 2-1.

2.6 INTERFACE CONNECTIONS

The Model 848TCM can be remotely controlled by an IEEE-488 bus controller. The controller must be connected to the bus connector at the rear panel of the power source. Up to 15 instruments may be controlled by a bus controller at one time.

2.7 FREQUENCY/AMPLITUDE PROGRAM RANGE OPTIONS

The frequency and voltage range of the Model 848TCM has been set-up at the factory according to the 848TCM model number suffix (refer to paragraph 1.3) to operate from 45 Hz to 5000 Hz and from 0 volts to 135 volts or 270 volts. The ranges may be changed in the field to any of the optional frequency and voltage ranges (see Table 2-1).

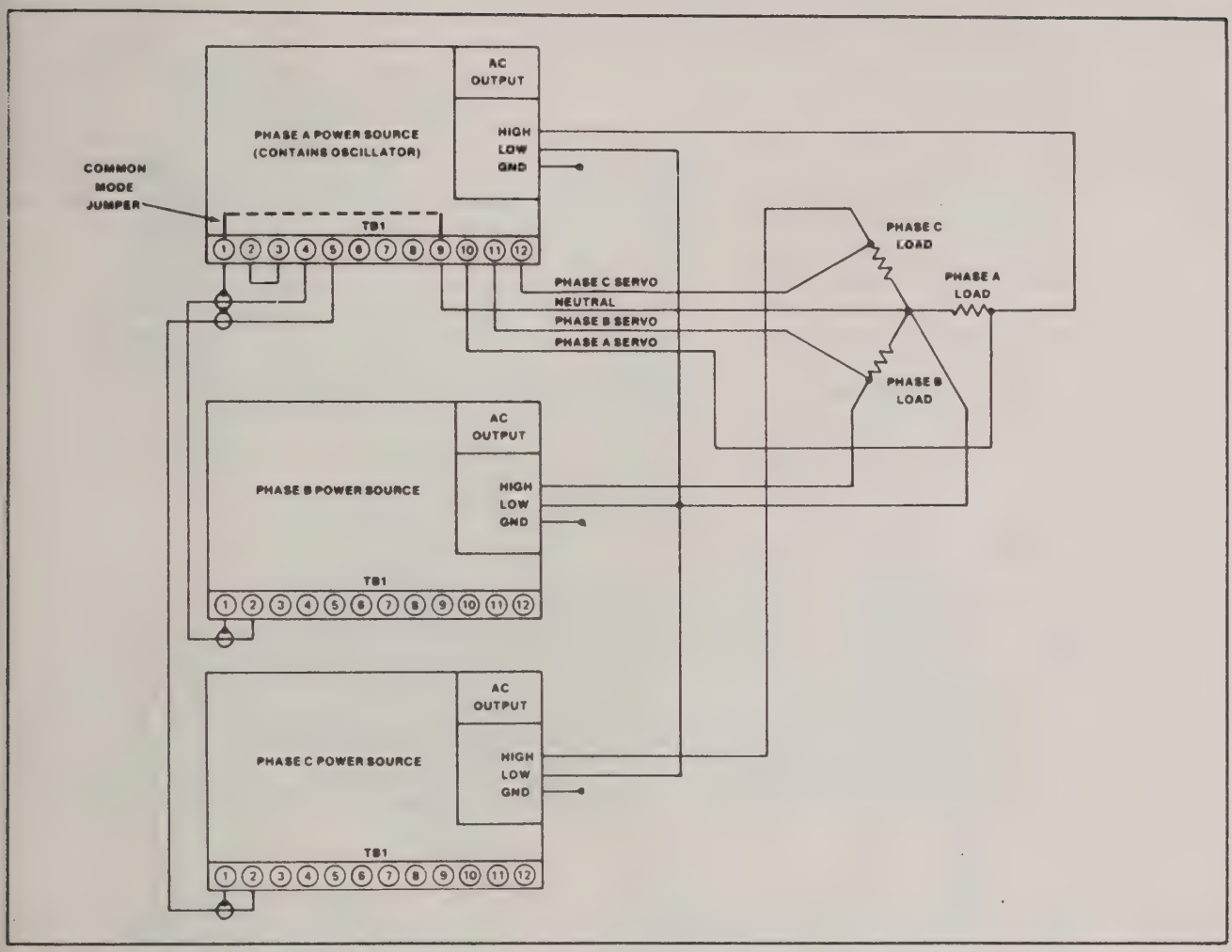


Figure 2-1A. Polyphase Power Source System Connections Using Individual Units.

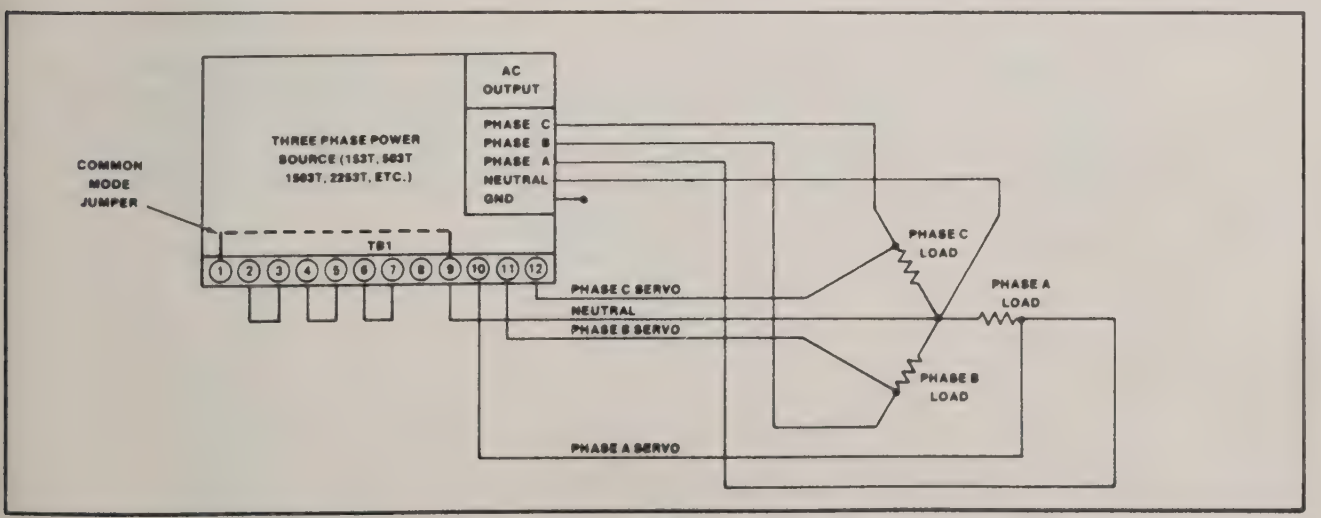


Figure 2-1B. Polyphase Power Source System Connections Using Single Unit.

RANGE	CONFIGURATION
0.0 to 135.0 volts	A1S1 ON. Power source on 135-volt range.
0.0 to 270.0 volts	A1S1 OFF. Power source on 270-volt range.
XX.XX Hz to 99.99 Hz	A1W1 installed, A1W2, A1W3 removed.
XXX.X Hz to 999.9 Hz	A1W2 installed, A1W1, A1W3 removed.
XXXX Hz to 2000 Hz	A1W3 installed, A1W1, A1W2 removed. Adjust A1R44 to inhibit above 2000 Hz.
XXXX Hz to 5000 Hz	A1W3 installed, A1W1, A1W3 removed. Adjust A1R44 to inhibit above 5000 Hz.
XXXX Hz to 9999 Hz	A1W3 installed, A1W4 installed, A1W1 A1W2 removed.

Table 201. Programming Range.

2.7.1 FREQUENCY RANGE OPTION

To select the 99.99 Hz range remove jumper A1W3 and add jumper A1W1. To select the 999.9 Hz range, remove A1W3 and add jumper A1W2. To allow the Model 848TCM to operate to 9999 Hz jumpers A1W3 and A1W4 must be installed. All jumpers are on the bottom printed circuit card at the rear edge. If the 999.9 Hz range is enabled the frequency decimal point must be enabled by adding a 220 ohm resistor for A2R36. Optionally, the 99.99 Hz range decimal point is enabled by adding a 220 ohm resistor for A2R35.

2.7.2 AMPLITUDE RANGE

The 135 volt range is enabled to match the power source 135V range by setting switch A1S1 to the ON position. The 270V range is selected by setting A1S1 to the OFF position.

2.8 ACCEPTANCE TEST

To conduct these tests, the Model 848TCM must be installed into an AC power source. The remote sense input must be connected as shown in Figure 201. Program any voltage and frequency combination and confirm the voltage accuracy to Figure 2-2. The voltage error for both the 135 and 270 volt ranges are shown in Figure 2-2 separated by a slash (/).

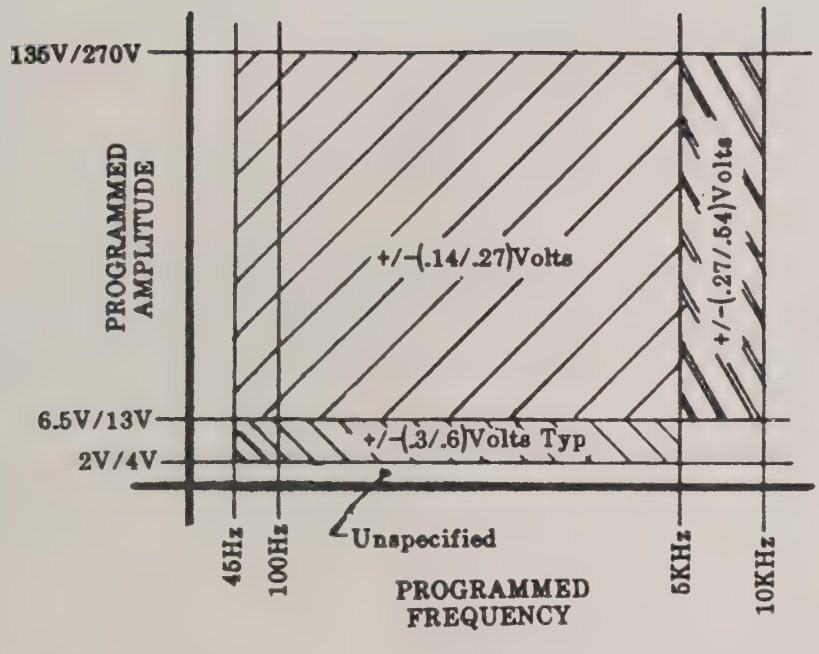


Figure 2-2
Performance Error Limits

SECTION 3 OPERATION

3.1 GENERAL

This section of the manual describes the operation of the Model 848TCM front panel display and keyboard. The operation of the IEEE-488 interface is also explained. Several program examples using the Hewlett Packard series 80 controller are also shown.

3.2 DISPLAY

There are two related sections of the Model 848TCM display. One section consists of four LED annunciators labeled PRG for program, AMP for amplitude, FRQ for frequency and REM for remote.

The other section of the display consists of a four character alphanumeric LED display with decimal point.

3.2.1 ANNUNCIATORS

When the AMP annunciator is illuminated, the value in the four character display indicates the actual programmed output voltage (output mode). Likewise when the FRQ annunciator is illuminated the value in the display is the programmed output frequency in hertz.

The PRG annunciator is illuminated when the first number key is depressed after power-up or a prior program entry. The PRG annunciator is illuminated (program mode) with the AMP or FRQ annunciator to allow the operator to inspect the value before it is transferred to the output.

While the PRG and AMP or FRQ are illuminated simultaneously, the decimal justification of the amplitude or frequency parameter may be checked before it is transferred to the output.

3.2.2 CHARACTER

In addition to indicating the four digits of amplitude and frequency, the character display generates the following alpha messages:

PL	X	service request X.
EP		empty program register
P	X	recall program register X.
E	XX	error message XX.
L	X	load register X.

where X is any number 0 through 0.

Table 3-3 illustrates the display response to various program examples.

3.2.3 ERROR MESSAGES

Refer to Table 3-1 for the meaning of error messages.

ERROR MESSAGE	PROBLEM
E 64	Phase A fault
E 65	Phase B fault
E 66	Phase C fault
E 67	Phase A, B fault
E 68	Phase A, C fault
E 69	Phase B, C fault
E 70	Phase A, B, C fault
E 71	Frequency limit exceeded
E 72	Program Syntax Error
E 73	Device Command Error (attempt to exceed amplitude or frequency range)
E 74	Message Exeeds DMA Buffer size
E 75	Not Assigned
E 76	RAM Failure during Built In Test
E 77	ROM Failure during Built In Test
E 78	GPIB Message sent with Model 848TCM in LOCAL MODE

Table 3-1 Error Messages

KEY	DESCRIPTION
0 through 9	Set FRQ, AMP Values. Identify Status Bytes 80 through 89. Identify Registers 0 through 9.
AMP	Display output amplitude value. Identify amplitude program value.
FRQ	Display output frequency value. Identify frequency program value.
PRG	Load program register.
REC	Recall program register.
SRQ	Generate GPIB Service Request.
ENT	Enter (output) frequency and amplitude value.

Table 3-2 Keyboard Key Description

COMMENT	ORDER OF OPERATION	KEY SEQUENCE	ANNUNCIATORS	DISPLAY	OUTPUT
PROGRAM AMPLITUDE	1	1, 1, 1, 1	PRG	1111	0V/60 Hz
	2	AMP	PRG, AMP	111.1	
	3	ENT	AMP	111.1	111.1V/60 Hz
PROGRAM FREQUENCY	1	4, 0, 0	PRG	400	111.1V/60 Hz
	2	FRQ	PRG, FRQ	400	
	3	ENT	FRQ	400	111.1V/400 Hz
SIMULTANEOUS AMP, FRQ CHANGE	1	6, 0	PRG	60	111.1V/400 Hz
	2	FRQ	PRG, FRQ	60	
	3	1, 1, 5, 0	PRG	1150	
	4	AMP	PRG, AMP	115.0	
	5	ENT	AMP	115.0	115.0V/60 Hz
SERVICE REQUEST	1	0, SRQ	PRG	PL 0	115.0V/60 Hz
	2	9, SRQ	PRG	PL 9	
RECALL UNPROGRAMMED REGISTER #1	1	1, REC	PRG	P 1	115.0V/60 Hz
	2	REC AMP	PRG AMP	EP .	
	3	REC FRQ	PRG FRQ	EP	
LOAD PROGRAM REGISTER #1	1	4, 0, 0, FRQ	PRG, FRQ	400	
	2	1, 2, 3, 5 AMP	PRG, AMP	123.5	
	3	1, PRG	PRG	L 1	
RECALL REGISTER #1	4	1, REC	PRG	P1	115.0V/60 Hz
	5	REC, AMP	PRG, AMP	123.5	
	6	REC, FRQ	PRG, FRQ	400	
	7	ENT	AMP	123.5	123.5V/400 Hz
CLEAR	1	1, 2, 3, 4	PRG	1234	123.5V/400 Hz
	2	HOLD 0 KEY	PRG	0	
PROGRAM 0 VOLTS		AMP, ENT	AMP	.0	0V/400 Hz

TABLE 3-3
KEYBOARD OPERATION

3.3 LOCAL OPERATION

All local programming is performed on a 16 key keyboard. There are ten number keys and six function and control keys. Table 3-2 describes the function of the sixteen keyboard keys. Table 3-3 illustrates the various key sequences of the keyboard and the resulting display and output.

3.3.1 NUMBER KEYS

Depressing any number key after the AMP or FRQ (output mode) causes all characters in the display to be cleared except for the number key depressed. Holding the 0 key depressed will cause all non-zero leading characters to be left shifted until only a single 0 remains. All leading zeros are blanked.

3.3.2 FREQUENCY ENTER

After entering a number sequence (ex., 6,0), depressing the FRQ key will cause the FRQ annunciator to illuminate. If the Model 848TCM is on one of the high frequency ranges (ex., 9999 Hz, 5000 Hz or 2000 Hz), no decimal point will illuminate. The Model 848TCM will interpret the displayed value in one Hz increments (60 Hz example).

If the 999.9 Hz range is enabled, the number sequence should be 6,0,0 before the FRQ is depressed. The display will then indicate 60.0 to illustrate .1 Hz resolution after FRQ is depressed.

To program the same 60 Hz on the 99.99 Hz range requires a number sequence of 6,0,0,0 before the FRQ key is depressed. After the FRQ key is depressed the display will indicate 60.00 to illustrate .01 Hz resolution.

3.3.3 AMPLITUDE ENTER

To initiate an amplitude program, a number sequence must be followed by depressing the AMP key. The number sequence 1,1,5,0 followed by the AMP key will cause the AMP annunciator to illuminate with display indicating 115.0 volts. The amplitude output mode will be executed by depressing the ENT key.

3.3.4 PROGRAM REGISTER

To program any register 0 through 9, the PRG key is used. Both an amplitude and frequency parameter must be loaded into a program register.

The program load routine is initiated by entering the amplitude and frequency program mode without depressing the ENT key. The program number key (0 through 9) must be depressed following the amplitude or frequency program mode. Depressing the PRG key after the register number completes the register loading sequence

ABBREVIATION	DEFINITION
ATN	Attention. A logic line on the GPIB asserted only by the controller to indicate the data on the buss represents a bus message.
CR	An ASCII carriage return.
DCL	Device Clear. A universal bus message to initialize all instruments to their power-on states.
END	End. A message conveyed when a talker uses the EOI line with the last data byte of a data string.
EOI	End Or Identify. A logic line on the GPIB asserted by a talker to indicate the last byte of a data string.
EOS	End Of String. A delimiter message that consists of a data byte(s) to indicate the end of a data string.
GET	Group Execute Trigger. A GPIB message to trigger an addressed instrument.
GTL	Go To Local. A GPIB message to put an addressed instrument in the local control mode.
IFC	Interface Clear. A logic line on the GPIB asserted by the controller to clear all interfaces (ex., default to unlisten and untalk).
LF	An ASCII line feed.
REN	Remote Enable. A logic line on the GPIB asserted by the controller. REN enables an instrument to go to local when addressed.
SDC	Selected Device Clear. A GPIB message to initialize an addressed instrument to its Power-on state.

Table 3-4 Commonly Used Abbreviations

3.3.5 RECALL REGISTER

Amplitude and frequency operating parameters may be recalled from a loaded memory register (ref. 3.3.4).

A one digit number is entered in the program mode followed by depressing the REC key. The PRG annunciator will be illuminated to indicate the Model 848TCM is not in the output mode.

If the REC key is followed by depressing the ENT key, the Model 848TCM will go to the output mode and enter the operating parameters recalled from memory. The parameters may be first checked before going to the output mode by first depressing the REC followed by the AMP key to check the amplitude value. Frequency is checked by depressing the REC key followed by the FRQ key. The parameters are outputted when the ENT key is depressed.

3.3.6 SERVICE REQUEST

The service request key, SRQ, is used to generate an IEEE-488 Service Request to the Bus controller. During a subsequent serial poll the Model 848TCM will send a Status Byte to the controller that is a function of the number key depressed preceeding the SRQ key. The decimal value of the Status Byte will equal the number key plus 80. Ten Status Bytes can be generated from the keyboard with values 80 through 89.

3.4 REMOTE OPERATION

Programming for the Model 848TCM IEEE-488 GPIB interface consists of setting the Model 848TCM unit address and sending the proper ASCII alphanumeric characters to identify the parameter and the numerical value. The description of the abbreviations used in this section are listed in Table 3-4.

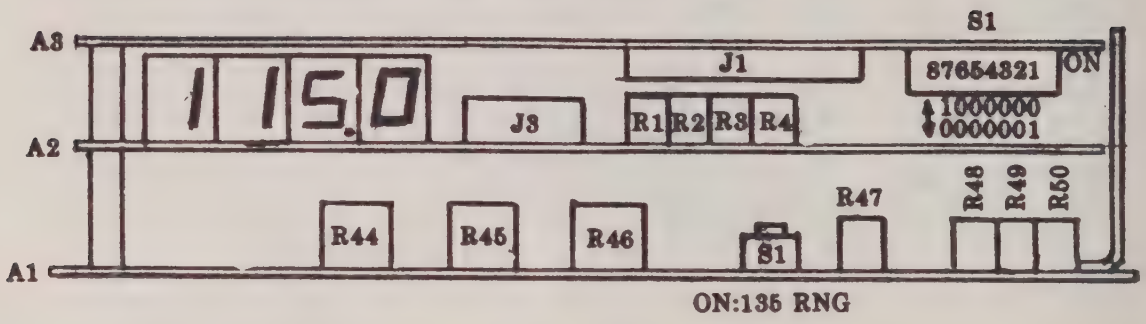
3.4.1 ADDRESS SELECTION

The unit address switch is shown in Figure 3-1. Switch sections one through five correspond to IEEE-488 address bits A1 through A5 respectively. The five bits make up a five bit binary number with A1 as the LSB. The decimal equivalent of the binary number corresponds to the decimal value of the address of 0 through 30. Refer to Table 3-6 for the equivalent HEX, Binary, ASCII and Decimal equivalents to the decimal address. The switches are set at the factory to 00001 or decimal address 1. The true position, "1", of the listen address switch is the OFF position (ref. Table 3-5).

Table 3-5. Unit Address Switch Functions

SECTION POSITION	FUNCTION	SWITCH TRUE
1	Listen Address A1	OFF
2	Listen Address A2	OFF
3	Listen Address A3	OFF
4	Listen Address A4	OFF
5	Listen Address A5	OFF
6	Listen Only Mode	OFF
7	RSV	ON
8	Not used	

ADJUSTMENT/SWITCH LOCATIONS



S1 SECT	DESCRIPTION
S1-1	LISTEN ADDRESS A1
S1-2	LISTEN ADDRESS A2
S1-3	LISTEN ADDRESS A3
S1-4	LISTEN ADDRESS A4
S1-5	LISTEN ADDRESS A5
S1-6	LISTEN ONLY
S1-7	SERVICE REQUEST
S1-8	NOT USED

FIGURE 3-1

Table 3-6. Listen Address Group.

LISTEN ADDRESS	HEX	BINARY						DECIMAL	ASCII
			A5	A4	A3	A2	A1		
0	20	001	0	0	0	0	0	32	SP
1	21	001	0	0	0	0	1	33	!
2	22	001	0	0	0	1	0	34	"
3	23	001	0	0	0	1	1	35	#
4	24	001	0	0	1	0	0	36	$
5	25	001	0	0	1	0	1	37	%
6	26	001	0	0	1	1	0	38	&
7	27	001	0	0	1	1	1	39	'
8	28	001	0	1	0	0	0	40	(
9	29	001	0	1	0	0	1	41	)
10	2A	001	0	1	0	1	0	42	*
11	2B	001	0	1	0	1	1	43	+
12	2C	001	0	1	1	0	0	44	,
13	2D	001	0	1	1	0	1	45	-
14	2E	001	0	1	1	1	0	46	.
15	2F	001	0	1	1	1	1	47	/
16	30	001	1	0	0	0	0	48	0
17	31	001	1	0	0	0	1	49	1
18	32	001	1	0	0	1	0	50	2
19	33	001	1	0	0	1	1	51	3
20	34	001	1	0	1	0	0	52	4
21	35	001	1	0	1	0	1	53	5
22	36	001	1	0	1	1	0	54	6
23	37	001	1	0	1	1	1	55	7
24	38	001	1	1	0	0	0	56	8
25	39	001	1	1	0	0	1	57	9
26	3A	001	1	1	0	1	0	58	:
27	3B	001	1	1	0	1	1	59	;
28	3C	001	1	1	1	0	0	60	<
29	3D	001	1	1	1	0	1	61	=
30	3E	001	1	1	1	1	0	62	>
UNL	3F	001	1	1	1	1	1	63	?

3.4.2 LISTEN ONLY

Switch section 6 is the Listen Only Mode. When this switch is in the "1" or true position the Model 848TCM will operate in the non-addressed mode. It will respond to all ASCII data on the bus. The addressable mode, the normal mode, is selected by placing the switch in the "0" or false position.

3.4.3 MESSAGE FORMAT

The message sent to the Model 848TCM must have the following format:

HHHXXX----E±NND

Where

H = Three letter mnemonic for message header
X = Program value up to 255 digits
E = Optional ASCII E for exponent identification
± = Exponent sign
N = Exponent value 0 to ±63
D = Message delimiter

More than one message header with its corresponding value may be sent in one setup string with a common message delimiter.

MNEMONIC	DATA FIELDS NOTATION	EXAMPLE	DEFINITION
AMP	Unsigned Value with decimal point or Unsigned value with or without decimal point and with exponent	0.0 to 300.0-① 0.0 to 3.0-① E2	AMPLITUDE
FRQ	Unsigned Value with decimal point or Unsigned Value with or without decimal point and with exponent	0 to 9999.0-① 0.0 to 9.999-1 E3	FREQUENCY
RNG	Decimal 1 or 2	1 or 2	RANGE
PRG	Unsigned single digit without decimal point	0 through 9	PROGRAM
REC	Unsigned single digit without decimal point	0 through 9	RECALL
TLK	Unsigned three digit value without decimal point	0 through 999	TALK
TRG	None		TRIGGER

Notes:
① less than 256 places following decimal point.

Table 3-7
Program Headers

3.4.3.1 PROGRAM HEADER

A Program Header is a mnemonic of a series of three ASCII characters used to select a Model 848TCM function or identify the data it precedes. The header is an abbreviation of the program function it identifies. See table 3-7 for the definitions of the Program Headers and their related data fields.

3.4.3.1.1 AMPLITUDE

The three letter abbreviation AMP is used to represent the amplitude command. The following examples represent ASCII strings the Model 848TCM will recognize for values of amplitude.

0.0 volts	AMP0	AMP0.0	AMP0E0
10.5 volts	AMP10.5	AMP1.05E1	AMP105E-1
100.0 volts	AMP100	AMP100.0	AMP1E2

3.4.3.1.2 FREQUENCY

The frequency command is represented by the abbreviation FRQ. The following examples represent ASCII strings the Model 848TCM will recognize for values of frequency:

400 Hertz	FRQ400	FRQ400.0	FRQ4.0E2
1234 Hertz	FRQ1234	FRQ1234.0	FRQ1.234E3
60.23 Hertz	FRQ60.23	FRQ6.023E1	FRQ6023E-2
100 Hertz	FRQ.000000001E11		

3.4.3.1.3 RANGE

The range command is represented by the abbreviation RNG.

The numbers 1 and 2 are used to represent the 135 and 270 volt ranges respectively. The range command may be included in a setup string with any combination of amplitude and frequency.

The range command when transmitted without an amplitude value will cause the Model 848TCM to default to zero volts. A range command when inluded with an amplitude command will first cause the Model 848TCM to set the amplitude to zero before executing the new amplitude parameter (ex., RNG2AMP270).

3.4.3.1.4 PROGRAM

The program command has the abbreviation PRG. This command must be used with an amplitude and frequency command. The PRG command stores the setup values into the register location identified by the value following the PRG command. The register is identified by a single digit 0 through 9.

The following string will load 115 volts and 60 Hertz into register 0:

FRQ60AMP115PRG0

3.4.3.1.5 RECALL

The recall command has the abbreviation REC. This command will recall an amplitude and frequency value previously programmed into a register. The register is identified by a single digit 0 through 9 following the REC command. An amplitude value and a frequency value must have both been previously programmed into the register before the recall command can be executed.

The following string will recall and execute values from register 0:

REC0

3.4.3.1.6 TRIGGER

The trigger mode of the Model 848TCM is enabled when the mnemonic TRG is added to a setup string. The trigger command may be inserted anywhere in the string. When the mnemonic is detected by the Model 848TCM, it will delay execution of the new setup values until either the GPIB Device Trigger is sent by the bus controller or the Model 848TCM is put into the local control mode and the ENT key is depressed.

The trigger mode may also be enabled in the local control mode by programming an amplitude and frequency value without depressing the ENT key. The Model 848TCM will then execute the setup values in the remote mode when the Device Trigger is received.

The following setup string will recall the values from register 9 and delay execution until the GET message is received. (note: GET is the abbreviation for the GPIB Group Execute Trigger message and does not represent a series of ASCII characters. See Table 3-1).

REC9TRG

To set up 0 volts, 400 hertz and wait for GET

FRQ400AMP0TRG

To store 4321 hertz 123.4 volts into register 3 and then output 4321 Hz, 123.4 volts

FRQ4321AMP123.4PRG3REC3

3.4.3.2 DATA FIELDS

Amplitude and Frequency values may be sent to the Model 848TCM as an unsigned value with a decimal point or a decimal point with an exponent.

3.4.3.2.1 UNSIGNED VALUE WITH DECIMAL POINT

The Decimal Point for the frequency and amplitude value may be either sent or inferred. The two following ASCII strings will represent 115 volts to the Model 848TCM.

AMP115
AMP115.0

There may be any number of digits following the decimal point, not to exceed the 255 byte DMA buffer, but only the Least Significant Digit (LSD) of resolution will be recognized. The LSD for amplitude is tenths of volts. The LSD for frequency is either hundredths, tenths or Hertz for the 99.99 Hz, 999.9 Hz or 9999 Hz ranges respectively.

3.4.3.2.2 UNSIGNED VALUE WITH DECIMAL POINT AND EXPONENT

Any amplitude and frequency value may be of a mixed form with a decimal point and exponent.

The exponent may be either a single digit or double digit up to ±63. The following ASCII strings will represent 115 volts to the Model 848TCM:

```
AMP1.15E2
AMP1.15E+2
AMP1.15E+02
AMP1150E-1
```

A positive exponent value is represented by either an ASCII "+" or an unsigned value.

3.4.3.3 DELIMITER

The End of String delimiter recognized by the Model 848TCM is the ASCII Line Feed (LF). The End or Identify (EOI) IEEE-488 message will also be recognized.

An END or End of String (EOS) message will be recognized by the Model 848TCM as a message delimiter or message separator.

The END message is sent by setting the IEEE-488 End or Identify line true with the last data byte.

The EOS message will be recognized by the Model 848TCM as the ASCII Line Feed (LF). The EOS message may be changed to Carriage Return (CR), Line Feed (LF) by changing jumper A3W5 to position A3W6. When the jumper is changed to position A3W7 the ASCII Carriage Return will represent the EOS message.

3.4.3.4 NULL CHARACTERS

An ASCII character that can be included anywhere in the setup string without altering the meaning of the string is called a null character.

Whenever the Model 848TCM encounters a null character, it ignores the character. All null characters are unprintable. See Table 3-8 for all acceptable ASCII null characters.

ASCII	HEX	DECIMAL
NULL	00	0
HT	09	9
SP	20	32

Table 3-8
NULL (Unexecutable) Characters

3.4.4 SERVICE REQUEST

The IEEE-488 Service Request (SRQ) is used by the Model 848TCM to indicate to the bus controller that it needs service.

Any malfunction detected by the Model 848TCM microprocessor will generate the SRQ. In addition, the SRQ will be generated in the local control mode by the keyboard SRQ key.

Only operational faults detected in the Remote control programming mode will cause the SRQ to be generated. The operational faults consists of command range errors, syntax error, frequency limit exceeded, or phase A, B, C faults (See Table 3-9).

3.4.4.1 STATUS BYTE

Once the bus controller has detected the interrupt caused by the SRQ it must determine the instrument needing service by the Serial Poll. During the polling routine the instrument needing service will return a Status Byte greater than decimal 63. The Status Byte values for various faults are given in Table 3-9.

STATUS BYTE (DECIMAL)	
64	Phase A fault
65	Phase B fault
66	Phase C fault
67	Phase A, B fault
68	Phase A, C fault
69	Phase B, C fault
70	Phase A, B, C fault
71	Frequency limit exceeded
72	Program syntax error
73	Device command error (attempt to exceed amplitude or frequency range)
74	Message exceeds DMA buffer size
76	RAM failure during Built In Test
77	ROM failure during Built In Test
78	BUS message sent with Model 848TCM in LOCAL
80	0 Key followed by SRQ key
89	9 key followed by SRQ key

Table 3-9
STATUS BYTE VALUES

STATEMENT	DESCRIPTION
CLEAR 7	Universally sets all instruments to their power-on states by sending the GPIB message DCL.
CLEAR 701	Sets only instrument with listen address "1" to its power-on state by sending the GPIB message SDC.
LOCAL 7	Universally sets all instruments into their local control mode by deasserting REN.
LOCAL 701	Sets only instrument with listen address "1" to its local control mode by sending the GTL message.
REMOTE 7	Sets REN true.
REMOTE 701	Sets instrument with listen address "1" to remote.
RESET 7	Clears all instrument interfaces to unlisten and untalk by toggeling IFC.
RESUME 7	Sets ATN false.
OUTPUT 701; "AMP"; V	Sends the data string AMP followed by the numerical value of variable V to the instrument with listen address "1".
STATUS 7,1;A	This statement reads the SR1 register of the series 80 controller for the interrupt cause. This statement is necessary to clear the Service Request flag in the controller.
ENABLE INTR 7; 8	This statement allows the series 80 controller program to be interrupted when a GPIB instrument generates an SRQ.
ON INTR 7 GOSUB100	This statement will cause the program to go to an interrupt subroutine at 100.
TRIGGER 7	This statement triggers all addressed instruments by sending the GET message.
TRIGGER 701 ①	This statement will trigger only the instrument with listen address "1" by sending the GET message.
A=SPOLL (7)	Sets variable A equal to the decimal value of the Status Byte of an instrument previously addressed to talk.
A=SPOLL (701) ①	Sets variable A equal to the decimal value of the Status Byte of the instrument with listen address "1".

Table 3-10
HP SERIES 80 CONTROLLER STATEMENTS

NOTES: ① Preferred Statement

3.4.5 HEWLETT PACKARD SERIES 80 CONTROLLER PROGRAMMING

For the following program examples the Model 848TCM listen address is "1" and the controller interface is select code "7".

3.4.5.1 SERIES 80 CONTROLLER STATEMENTS

Table 3-10 lists some of the Series 80 Controller statements that may be useful in programming the Model 848TCM on the GPIB. For additional statements and their descriptions refer to the Hewlett Packard I/O Programming Guide for the Series 80 Computer.

3.4.5.1.1 OUTPUT

The following program will step the Model 848TCM program voltage from 0 volts to 130 volts in .1 volt steps:

```
10 REMOTE 7
20 FOR V=0 TO 130 STEP .1
30 OUTPUT 701 ;"AMP";V
40 NEXT V
50 END
```

3.4.5.1.2 TRIGGER

The following program will load the parameters of 115 volts and 400 hertz. The Model 848TCM will output the parameters only after the K1 special function key of the Series 80 Controller is depressed to send the GET message.

```
10 REMOTE 701
20 OUTPUT 701 ;"AMP115 FRQ400 TRG"
30 ENABLE KBD 32+64 ! ENABLE PAUSE AND SPECIAL FUNCTION KEYS
40 ON KEY# 1 GOTO 100 ! USE KEY K1 FOR DEVICE TRIGGER
50 GOTO 40

100 TRIGGER 701
110 END
```

3.4.5.1.3 SERVICE REQUEST STATEMENTS

The program example for SRQ uses the statements RESET, STATUS, ON INTR, ENABLE INTR, and SPOLL.

The RESET statement in line 30 clears the interface, unlistens and untalks all instruments by the IFC. It also puts all instruments on the bus into local by momentarily making REN false.

The STATUS statement in line 40 is necessary to clear the Controller status register from any possible previous Service Request (SRQ) interrupts. The HP I/O Programming Manual is not clear on the use of the STATUS statement but it must be used after every SRQ and before enabling or reenabling the SRQ interrupt to prevent false SRQ indication. Line 50 causes the program to go to the interrupt subroutine at line 100.

The ENABLE INTR statement in line 60 enables the SRQ to generate an interrupt. A worthless program follows in lines 70 and 80 that executes until a SRQ is generated by the Model 848TCM. The SRQ interrupt subroutine is between lines 100 and 210.

The STATUS statement in line 120 clears the SRQ.

Line 130 generates a Status Byte from the Model 848TCM with listen/talk address "1". The variable A will be equal to the value of 80 through 89 for the SRQ keyboard entry of 0 through 9 respectively.

If the value is between 80 and 89 the Status byte value will be displayed with line 170.

Since the Model 848TCM is in the local mode or operation, there will be no other error messages. If the Model 848TCM were left in the Remote mode, other fault messages would be display by line 190.

```
10 ! RESET INTERFACE WITH IFC
20 ! TOGGLE REN TO PUT 848TCM INTO LOCAL FOR KEYBOARD SRQ
30 RESET 7
40 STATUS 7,1;Z ! READ STATUS TO CLEAR HP SERIES 80 STATUS
   REGISTER
50 ON INTR 7 GOSUB 100
60 ENABLE INTR 7;8 ! ENABLE SRQ TO GENERATE INTERRUPT
70 ! SAMPLE PROGRAM TO WAIT FOR SRQ INTERRUPT
80 GOTO 70
100 ! SERVICE REQUEST FOR DEVICE 1
110 ! USE SERIAL POLL TO DETERMINE STATUS BYTE
120 STATUS 7,1;Z ! READ STATUS TO CLEAR SRQ
130 A=SPOLL (701)
140 ! EVALUATE STATUS BYTE TO CHECK FOR SYSTEM FAULT
150 IF A>89 OR A<80 THEN GOTO 190
160 ! KEYBOARD GENERATED STATUS MESSAGE
170 DISP "THE KEYBOARD MESSAGE IS ";A
180 GOTO 200
190 DISP "THE SYSTEM FAULT MESSAGE IS ";A
200 ENABLE INTR 7;8 ! REENABLE INTERRUPT
210 RETURN
```

SECTION 4 ADJUSTMENT PROCEDURE

4.1 GENERAL

The following adjustment procedure, or any part of it, may be performed on a routine basis to ensure that the oscillator remains within the specified performance limits. Paragraphs 4.4 through 4.8 only need to be performed if a related component has been replaced. Paragraphs 4.9 through 4.10 need to be performed on a periodic basis.

Calibration of the Model 848TCM AC Power Controller requires a compatible power source(s) as shown in Figure 2-1.

Refer to Figure 3-1 for the adjustment locations.

4.2 RECOMMENDED TEST EQUIPMENT

Digital Voltmeter	0.05V accuracy on 200 volt range
Frequency Counter	Philips PM6671

4.3 PRELIMINARY STEPS

1. Connect the remote sense inputs as shown in Figure 2-1.
2. Apply power to the AC power supply system and allow at least fifteen minutes for stabilization.
3. Monitor the AC voltage output at the power source front panel terminals if the source is unloaded. If the source is loaded, monitor the AC voltage at the remote sense input on TB1 at the rear of the source containing the Model 848TCM or at the remote sense points. At TB1 the phase A input is across terminals 9 and 10, phase B across terminals 9 and 11 and phase C across terminals 9 and 12.

4.4 SINE CLOCK ADJUSTMENT

1. Connect the frequency counter between test point A2TP10 and ground at A2TP9.
2. Adjust A2C10 for a counter reading of 10,200,000 ±50 Hz.

4.5 FREQUENCY DETECTOR LOW LIMIT ADJUSTMENT

1. Turn A1R45 to its maximum CCW position.
2. Program 43 Hz.
3. Adjust A1R45 just to the point E 71 is displayed.
4. Program 44 Hz and verify that a frequency of 44 Hz is displayed to indicate that the low frequency limiter is not operating.
5. Seal A1R45.

4.6 FREQUENCY DETECTOR HIGH LIMIT ADJUSTMENT

1. Turn A1R44 to its maximum CCW position.

2. Program the Model 848TCM to a frequency 500 Hz above its highest frequency compatible with the power source being used (2500 Hz or 5500 Hz).

3. Adjust A1R44 just to the point E 71 is displayed.

4. Program the High Frequency Limit (2000 Hz or 5000 Hz) and verify the frequency is displayed on the Model 848TCM display.

5. Seal A1R44.

4.7 OPEN SENSE ADJUSTMENT

1. Open the phase A, B and C sense lines by removing all connections to TB1 terminals 10, 11 and 12.

2. Program the Model 848TCM to 100.0 volts. Hold the ENT key depressed - the last key stroke - to prevent the Model 848TCM from programming to 000.0 volts.

3. Adjust the phase, A, B and C power source gain controls for 110.0 volts ±.1 volt.

4. Connect the remote sense inputs as shown in Figure 2-1.

4.8 COMMON MODE ADJUSTMENT

Refer to Figure 2-1 and connect the remote sense leads. Initiall ensure that there is no connection between CIRCUIT GND (TB1, terminal 1) and either terminal 9, 10, 11 or 12.

4.8.1 Phase A Common Model Adjustment

1. Short TB1, terminal 10, to CIRCUIT GND (terminal 1).

2. Monitor the power source phase A output voltage with the digital AC voltmeter across TB1, terminals 9 and 10.

3. Program the Model 848TCM for 90 Hz and 100.0 volts. Record the voltmeter reading to within ±10 millivolts.

4. Remove the short from TB1, terminal 10, and connect it to TB1, terminal 9.

5. Adjust A1R49 for the same voltage recorded in step 3, ±10 millivolts. Seal A1R49.

6. Remove the short from TB1, terminal 9.

4.8.2 Phase B Common Mode Adjustment

1. Short TB1, terminal 11, to CIRCUIT GND (terminal 1).
2. Monitor the power source phase B output voltage with the digital AC voltmeter across TB1, terminals 9 and 11.
3. Program the Model 848TCM for 90 Hz and 100.0 volts. Record the voltmeter reading to within ±10 millivolts.
4. Remove the short from TB1, terminal 11, and connect it to TB1, terminal 9.
5. Adjust A1R48 for the same voltage recorded in step 3, ±10 millivolts. Seal A1R48.
6. Remove the short from TB1, terminal 9.

4.8.3 Phase C Common Mode Adjustment

1. Short TB1, terminal 12, to CIRCUIT GND (terminal 1).
2. Monitor the power source Phase C output voltage with the digital AC voltmeter across TB1, terminals 9 and 12.
3. Program the Model 848TCM for 90 Hz and 100.0 volts. Record the voltmeter reading to within ±10 millivolts.
4. Remove the short from TB1, terminal 12, and connect it to TB1, terminal 9.
5. Adjust A1R50 for the same voltage recorded in step 3 ±10 millivolts. Seal A1R50.
6. Remove the short from TB1, terminal 9.

STEP	AMPLITUDE	FREQUENCY	ADJUSTMENT	OUTPUT
1	10.0	90	A1R46 (A = 10)	Phase A = 010.0 ±0.01V
2	10.0	90	A2R1 (B = 10)	Phase B = 010.0 ±0.01V
3	10.0	90	A2R2 (C = 10)	Phase C = 010.0 ±0.01V
4	100.0 or 200.0	90	A1R47 (A = 100)	Phase A = 100.0 or 200.0 ±0.01V
5	100.0 or 200.0	90	A2R3 (B = 100)	Phase B = 100.0 or 200.0 ±0.01V
6	100.0 or 200.0	90	A2R4 (C = 100)	Phase C = 100.0 or 200.0 ±0.01V
7	Repeat steps 1 through 6			

Table 4-1 Periodic Adjustments

NOTE

Paragraphs 4.1 through 4.8 are the non-routine adjustments. The following paragraphs describe adjustments that are of a periodic nature and are summarized in Table 4-1.

4.9 10-VOLT ADJUSTMENT

1. Verify that the remote sense lines are connected as shown in Figure 2-1.

2. Program the Model 848TCM for 10.0 volts and 90 Hz.

3. Monitor the phase A output. Adjust A1R46 (A=10V) for 10.00 volts ±0.01 volts.

4. Monitor the phase B output. Adjust A2R1 (B=10V) for 10.00 volts ±0.01 volts.

5. Monitor the phase C output. Adjust A2R2 (C=10V) for 10.00 volts ±0.01 volts.

4.10 100-VOLT/200-VOLT ADJUSTMENT

NOTE

This adjustment is made at either 100 volts on the 135-volt range or 200 volts on the 270-volt range.

1. Program the Model 848TCM on either 100 volts or 200 volts.

2. Monitor the phase A output. Adjust A1R47 (A=100) for the programmed value ±0.01 volts.

3. Monitor the phase B output. Adjust A2R3 (B=100) for the programmed value ±0.01 volts.

4. Monitor the phase C output. Adjust A2R4 (C=100) for the programmed value ±0.01 volts.

5. Repeat the steps of paragraphs 4.9 and 4.10.

Appendix A

Code	Name	City	State
0000A	Electricord	Westfield	PA
0000C	Jackson Bros.	Waddon, Surrey	GB
0000S	OPCDA	Edison	NJ
0000W	Milton Ross Co.	Southampton	PA
0000Z	Timco	Los Angeles	CA
000AC	ITAC	Santa Clara	CA
000AD	Plessey	Westlake Village	CA
000AG	La France	Philadelphia	PA
000AH	Jan Crystal	Ft. Myers	CA
000AL	Data Components, Inc.	Santa Monica	CA
000AM	Kraus & Naimer	Santa Monica	CA
000AN	Ritz Instrument Transformer Co.	Redondo Beach	CA
000AS	Switches Incorporated	Mt. View	CA
00544	Metal-Cal Div., Avery Prod. Corp.	Inglewood	CA
00779	AMP Inc.	Harrisburg	PA
00853	Sangamo Electric Co.	Pickens	SC
00866	Goe Eng. Co., Inc.	City of Industry	CA
01002	G.E. Co., Ind. & Pwr. Cap. Dept.	John St. Hudson Falls	NY
01121	Allen-Bradley Co.	Milwaukee	WI
01139	G.E. Co., Silicone Products Dept.	Waterford	NY
01295	Texas Instruments	Dallas	TX
02111	Spectrol Electronics	City of Industry	CA
02333	Fairchild Controls Corp.	Hicksville, LI	NY
02375	American Insulating Machinery Co.	Philadelphia	PA
02538	Texas Electronics Co.	Dallas	TX
02660	Amphenol Corporation	Broadview	IL
02799	Use Code #72136		
03507	General Electric Company	Syracuse	NY
03508	General Electric Company	Syracuse	NY
03797	Eldema Corporation	Compton	CA
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls	NJ
03911	Clairex Corporation	New York	NY
04009	Arrow-Hart and Hegeman Elec. Co.	Hartford	CT
04713	Motorola Semiconductor Prod., Inc.	Phoenix	AZ
04963	3-M	St. Paul	MN
05245	Corcom Inc.	Chicago	IL
05276	Pomona Electronics Co., Inc.	Pomona	CA
05397	Kemet, Union Carbide Corp.	Cleveland	OH
05820	Wakefield Engineering, Inc.	Wakefield	MA
06383	Panduit Corp.	Tinley Park	IL
06514	Stantron, Wyco Metal Products	N. Hollywood	CA
06540	Amathom Elect. Hardware	New Rochelle	NY
06665	Precision Monolithics Inc.	Santa Clara	CA
06776	Robinson Nugent, Inc.	New Albany	IN
06915	Richco Plastics, Co.	Chicago	IL
07088	Kelvin Electric Company	Van Nuys	CA
07263	Fairchild Camera and Instr. Corp.	Mt. View	CA
07387	Birtcher Corporation	Los Angeles	CA
07556	Unitrack Calabro Plastics	Upper Darby	PA
07633	Epoxy Prod. Co., Allied Prod. Corp.	New Haven	CT
07716	IRC Incorporated	Burrington	IA
08065	Accurate Rubber and Plastics Co.	San Diego	CA
08261	Spectra Strip	Garden Grove	CA
08289	Blinn-Delbert Co., Inc.	Pomona	CA
08353	Bristol Co.	Toronto	CANADA
08524	Deutsch Fastener Corp.	Los Angeles	CA
08730	Vemaline Products Co.	Franklin Lakes	NJ
08779	Signal Transformer Co.	Brooklyn	NY
09353	C and K Components	Newton	MA
10389	Chicago Switch Inc.	Chicago	IL
11815	Cherry Rivet Div., Townsend Co.	Santa Ana	CA
12406	Elpac, Incorporated	Fullerton	CA
12697	Clarostat Mfg. Co., Incorporated	Dover	NH
13103	Thermalloy Company	Dallas	TX
14099	Semtech Corporation	Newbury Park	CA
14604	Elmwood Sensors Inc.	Cranston	RI
14655	Cornell-Dubilier Elect. Corp.	Newark	NJ
14726	Hollingsworth Co.	Phoenixville	PA
14752	Electro Cube, Incorporated	San Gabriel	CA
15238	ITT Semiconductors	Lawrence	MA
15636	Elec-trol	Northridge	CA
15801	Fenwall Electronics	Framingham	MA
15818	Amelco Teledyne, Incorporated	Mt. View	CA
15912	Ansley	Los Angeles	CA
16067	California Instruments Company	San Diego	CA
16758	Delco Radio Div., General Motors	Kokomo	IN
16956	Dennison	Framingham	MS
18076	Umpco	City of Industry	CA
18178	Vactec, Inc.	Maryland Heights	Mo
18324	Signetics	Sunnyvale	CA
18612	Vishay Instruments Inc.	Malvern	PA
18677	Scambe Mfg. Co.	Monterey Park	CA
18722	RCA	Mountaintop	PA
18736	Voltronics Corp.	Hanover	NJ
19080	The Robinson Company	Hawthorne	CA
21604	Buckeye Stamping Company	Columbus	OH
22599	Elastic Stop Nut Corporation	Van Nuys	CA
23050	Product Components Corp.	Hastings-on-Hudson	NY
23936	Pamotor, Incorporated	San Francisco	CA
24011	ECC	Burlington	MA
24444	General Semiconductor Industries Inc.	Tempe	AZ
24796	Parelco Inc.	Paramount	CA
25497	Meter Master	Los Angeles	CA
26806	American Zettler, Inc.	Costa Mesa	CA
27014	National Semi-Conductor Corp.	Santa Clara	CA
27191	Cutler-Hammer, Inc.	Milwaukee	WI
27264	Molex	Downers Grove	IL
27556	IMB Electronic Products	Santa Fe Springs	CA
27683	Varo, Incorporated	Ft. Garland	TX
27832	Hughes Aircraft	Newport Beach	CA

Code	Name	City	State
28480	Hewlett-Packard Co.	Palo Alto	CA
28520	Heyman Mfg. Company (Heyco)	Kenilworth	NJ
30039	International Components Corp.	Asbury Park	NJ
30983	Electra/Midland (Mepco/Electra)	San Diego	CA
30161	Aavid Engineering Inc.	Laconia	NH
30897	Dorann Company	Sylmar	CA
31951	Triridge Inc.	Pittsburgh	PA
32293	Intersil	Cupertino	CA
32559	Bivar, Inc.	Santa Ana	CA
33005	Jewell Electrical Instruments Inc.	Manchester	NH
33716	Kingsbacher Murray Co.	Los Angeles	CA
33855	Ducommun Inc.	Los Angeles	CA
34333	Silicon General	Westminster	CA
34649	Intel Corporation	Santa Clara	CA
44655	Ohmite Manufacturing Company	Skokie	IL
45722	Parker-Kalon	Clifton	NJ
46384	Penn. Eng. and Mfg. Corp.	Doylestown	PA
50522	Monsanto, Electronic Special Products	Cupertino	CA
51167	Aries Electronics Inc.	Frenchtown	NJ
51705	ICD/Rally	Palo Alto	CA
52072	Circuit Assembly Corp.	Costa Mesa	CA
54407	Power-One Co.	Camarillo	CA
56289	Sprague Electric Company	North Adams	MA
58474	Superior Electric Company	Bristol	CT
59730	Thomas and Betts Company	Elizabeth	NJ
63743	Ward Leonard Electric Co.	Mt. Vernon	NY
70318	Allmetal Screw Prod. Co.	Garden City	NY
70903	Belden Manufacturing Co.	Chicago	IL
71218	Bud Industries, Inc.	Willoughby	OH
71279	Cambridge Thermionic Corp.	Cambridge	MA
71400	Bussman Mfg. Div. McGraw-Edison Co.	St. Louis	MO
71450	CTS Corporation	Elkhart	IN
71468	ITT Cannon Electric Inc.	Los Angeles	CA
71590	Centralab Div. Globe-Union, Inc.	Milwaukee	WI
71707	Coto-Coil	Providence	RI
71744	Chicago Miniature Lampworks	Chicago	IL
71785	TRW Cinch	Chicago	IL
71984	Dow Corning Corp.	Midland	MI
72136	Elmenco (Electro Motive)	Willimantic	CT
72619	Dialight Corporation	Brooklyn	NY
72699	General Instruments	Newark	NJ
72982	Erie Technological Products Inc.	Erie	PA
73138	Beckman Instruments, Inc.	Fullerton	CA
73734	Federal Screw Products, Inc.	Chicago	IL
74193	Heinemann Electric Company	Trenton	NJ
74545	Harvey Hubbell, Inc.	Bridgeport	CT
74840	Illinois Condenser Co.	Chicago	IL
74970	E.F. Johnson Company	Waseca	MN
75042	TRW Electronic Components	Philadelphia	PA
75382	Kulka Electric Corporaion	Mt. Vernon	NY
75915	Littlefuse Incorporated	Des Plaines	IL
77132	United-Carr Inc., Patwin Division	Waterbury	CT
77342	Potter and Brumfield Div., AMF	E. Princeton	IN
78189	Shakeproof Div., Illinois Tool Works	Chicago	IL
78553	Tinnerman Products, Inc.	Cleveland	OH
79136	Johns-Manville Products Corp.	Chicago	IL
79136	Waldes Kohinoor Inc.	Long Island City	NY
79963	Zierick Mfg. Corporation	New Rochelle	NY
80031	Mepco/Electra	Morristown	NJ
80223	United Transformer Co.	New York	NY
80294	Bourns, Incorporated	Riverside	CA
81095	Triad Transformer Corp.	Venice	CA
81312	Winchester Electronics	Oakville	CT
81349	Military Specification or Commercial Generic Number		
81603	Raco Products Co.	Chicago	IL
82104	Standard Grigsby	Aurora	IL
82389	Switchcraft, Incorporated	Chicago	IL
82877	Rotron Manufacturing Co., Inc.	Woodstock	NY
82893	Vector Electronics Inc.	Sylmar	CA
83330	Herman H. Smith, Inc.	Brooklyn	NY
83486	Elco Tool and Screw Corp.	Rockford	IL
86684	RCA	Harrison	NJ
87034	Marco-Oak Industries	Anaheim	CA
88245	Useco Div., Litton Industries	Van Nuys	CA
90201	Mallory Capacitor Company	Indianapolis	IN
91637	Dale Electronics, Inc.	Columbus	NE
91662	Elco Corporation	Willow Grove	PA
91833	Keystone Electronics Corp.	New York	NY
92194	Alpha Wire Corporation	Elizabeth	NJ
94222	Southco, Incorporated	Lester	PA
95303	RCA	Cincinnati	OH
95987	Weckesser Company, Inc.	Chicago	IL
97525	Electronic Engineering Co.	Santa Ana	CA
98159	Rubber Teck, Incorporated	Gardena	CA
98291	Sealecto Corp.	Mamaroneck	NY
98376	Zero Mfg. Co. (West)	Burbank	CA
98978	IERC	Burbank	CA
99743	IMC	Maywood	CA
99800	Delevan Electronics Corporation	Aurora	NY

Revision J
January 5, 1982

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS, Division of Amstar Technical Products Co., Inc., warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are tubes, fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, and including the model number and serial number. On receipt of this information, service data or a Return Material Authorization (RMA) number will be given. Fill in RMA No. blank on shipping label attached opposite these instructions, pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No., or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS, San Diego, CA. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost, and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

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